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AT an expense of over $50,000 The Society sent a notable series of expeditions into Peru to investigate the traces of the Inca race. Their discoveries form a large share of our knowledge of a civilization waning when Pizarro first set foot in Peru.

THE Society also had the honor of subscribing a substantial sum to the expedition of Admiral Peary, who discovered the North Pole.

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THE Society is conducting extensive explorations and excavations in northwestern New Mexico, which was one of the most densely populated areas in North America before Columbus came, a region where prehistoric peoples lived in vast communal dwellings and whose customs, ceremonies, and name have been engulfed in an oblivion.

THE Society also is maintaining expeditions in the unknown area adjacent to the San Juan River in southeastern Utah, and in Yunnan, Kweichow, and Kansu, China—all regions virgin to scientific study.


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# MARVELS OF MYCETOZOA

## Exploration of a Long Island Swamp Reveals Some of the Secrets of the Slime Molds, Dwelling on the Borderland Between the Plant and Animal Kingdoms

By William Crowder

*With Illustrations in Color from Paintings by the Author*

IT was still dark when I made my way into the marshy maze. But soon, through the multitudinous openings in the emerald gloom overhead, the sky appeared like liquid splashes of rose-tinged silver, while the waning August moon seemed so tenuous that a breath could dissolve it.

Within the humid retreat the ferns and flowers and dense tangle of wildwood began obscurely to take shape through the shroud of misty shadows. Then, swiftly revealing itself in the increasing light of dawn, was seen in sharper outline that confusing chaos which is as typical of the temperate as it is of the tropic swamp.

Now was resolved a marvelous spectacle. On every side a bewildering riot prevailed; living forms reared themselves among the débris of dead and dying. . . .

This primeval picture of exotic exuberance lay not in some remote and far-away region of our globe, but within a minute's walk from the station of Millneck, on the easily accessible north shore of Long Island, less than 40 miles from New York City.

### A SEARCH FOR THE ODDEST OF LIVING THINGS

Although a swamp is a paradise for plants, the sweet Elysium and land of honey for many animals, it is, in the opinion of the average man, a dark and dismal reach—wet, insalubrious, filled even with the miasmatic vapors of death. The region seems not to be the birthplace of vigorous, pulsating life, but a vast and soggy graveyard, a treacherous sink wherein death and disaster are supreme.

Nor is this impression without certain cause. A swamp may well be said to have its moods. It appears at its best only to those in its confidence, revealing a quite charming aspect; to others it turns a sullen and forbidding countenance.

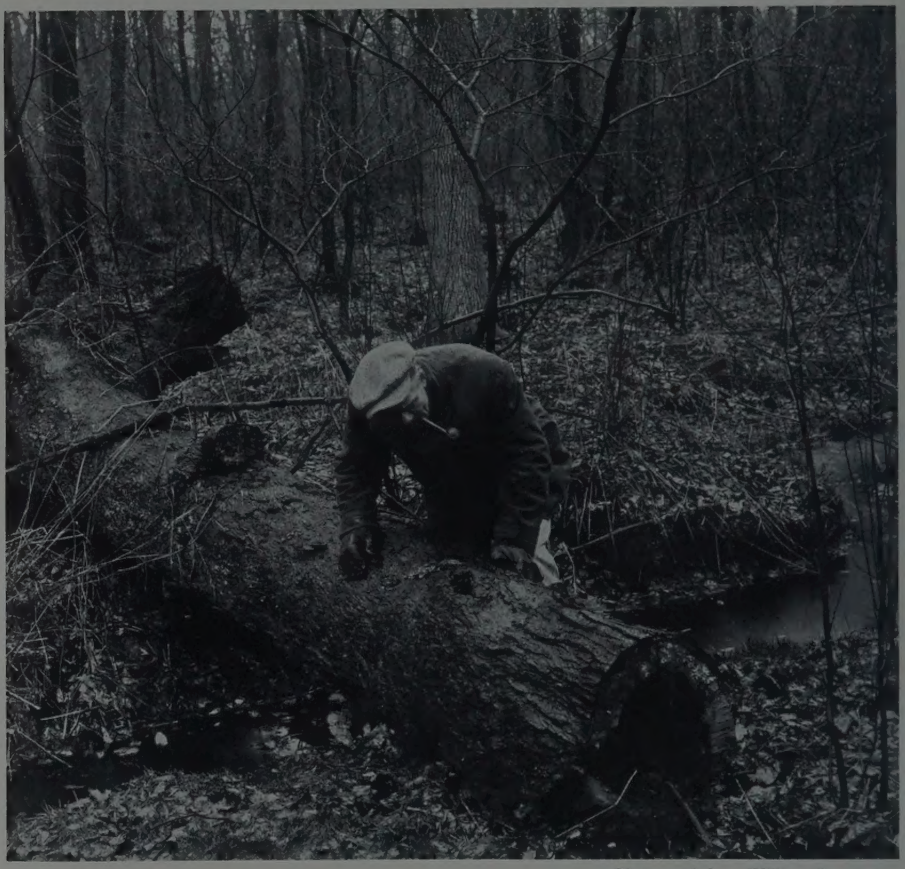
Here is maintained a constant ferment thrilling with life. Nowhere else, on land at least, does such prodigious fertility prevail. Even the sea, magnificent theater of life that it is, does not in certain aspects present a more extraordinary spectacle of the living drama.

It was not entirely from an overweening affection that I penetrated the reaches of my Long Island swamp while the rest of the world was asleep. My errand had been inspired by another and quite singular motive. I was on the way to watch the slime mold in its native haunts, and my objective was a certain old log, lying half-imbedded in the soft, soaked soil, which I knew to be harboring that oddest of living things.

Yet, absorbing as was my errand, I could not help drinking in the beauty of the surrounding scene in the gray light. Festooning the limbs and occasionally descending sheer to the earth, enormous vines hung suspended like giant swings or wrapped themselves like great garlands around the stately trees. On the trunks were expansive patches of greenish-gray lichens, oftentimes decorating their drab background of bark with fantastic figures.

### THE WHISPER OF MYRIADS OF MOVING CREATURES

Nearly every low-lying plant that bordered the shore of a brook carried a curious burden of short, slender blue sprigs, delicate and diaphanous, disposed variously over their leaves as well as their stems. Some of these sprigs exhibited an odd contorting movement, bending into tiny loops. Insects! But it was only



Photograph from William Crowder

IN THE HAUNTS OF MYCETOZOA

Although slime molds are usually dormant throughout the winter, a mild day will bring some of them into activity; whereupon they may be observed traveling over the logs (see text, page 424).

when the plants were closely approached that the multifarious hosts made certain their identity; for then the individuals detached and lifted themselves in a murmurous, rustling flight, the entire company dispersing in a glistening haze—a dissolving azure frost-cloud of somnolescent damsel flies!

The log I was seeking had lain on the spot for perhaps a century or more. It was now decayed throughout. Still, little evidence of this condition was manifest from the surface; only at the crumbling of its one visible end and in places where the bark had long since fallen away were there traces of its disintegration.

From the base, which was of a diameter so great that it reached almost the height of my waist, to a point where the trunk tapered toward what had once been the tree top, the cypress was nearly concealed from view by accumulations of detritus and a swaying forest of ferns, some of whose fronds, still laden with dew, looked like silvery plumes.

In one section the bark was mostly gone, and the surface of the exposed smooth wood was punctured with numerous holes—the entrances to the galleries of wood-boring beetles and other insects.

What a teeming population this fragile tenement contained! Applying my ear to

Photograph from William Crowder

SEARCHING FOR SLIME MOLDS

These two collectors are watching mycetozoa making their way over a sheltered log. A pile of wood like this—old, weathered, and in a moist situation—is invariably the habitation of numerous species of slime molds.

the surface, I could hear a faint rustling within, a ghost whisper of myriads of tiny creatures—white ants scraping, enlarging, extending their corridors. Day and night, summer and winter, the tread and toil of the tireless workers continue; nor do their activities abate until the trunk is honeycombed and the frangible shell breaks apart from its own weight; whereupon the termites migrate to a more propitious shelter to continue their destructive labors.

### WATCHING THE SLIME MOLDS GROW

Beyond these superficial details there was little in the appearance or the situation of the log to distinguish it from a hundred others lying about in the swamp.

But my business had to do only with that part of the log which was partially concealed by undergrowth and deadwood.

To clear away the plants and incidental débris was the work of a few seconds. Behold! Seldom ever before had such a gorgeous sight startled my unexpectant gaze.

Spreading out over the bark was a rich red coverlet, like the pile of a bright Persian rug, consisting of thousands of small, closely crowded, funguslike growths. They were the objects of my quest—myxomycetes or mycetozoa (see Color Plate XV).

A colony of these tiny organisms extended in an irregular patch over the top and sides of the trunk, covering an area nearly a yard in length and slightly less in breadth.

To such a soft, velvety coat a touch or two was irresistible; but on the merest contact of my finger a cloud of spores arose, settling upon the barer portion of

the bark as an impalpable film of reddish dust and leaving on my skin a tinge of ruby russet.

### EACH UNIT RESEMBLED A MUSHROOM

I brought my powerful pocket lens to bear upon the dainty individuals. Each unit, although actually less than a quarter of an inch in height, resembled, in the focus of my strong glass, a miniature morel, a small mushroom, though more marvelous than any I have ever seen.

Of the total height, a third was taken up by a slender stalk which at its base was attached to the bark. Surmounting this stalk was a cuplike expansion, which in turn supported a large, dense, elongated cluster of tangled threads—the sporangium (spore case).

That was all. Simple in form, in detail unadorned; yet how impressive! In the case of some individuals the sporangium was immature, as was evidenced by the filmy, iridescent membrane inclosing them. In others this membrane had burst and was still hanging in shreds, disclosing the compacted mass of spores within the network—indescribable in tint, in translucent texture, and in graceful dignity of form.

For want of a better term, I have called their color *red*. It was one of those rare reds, such as is produced by Nature only in her most delightful moods, as in the rosy reflex of a winter's dawn or in the evening glow that in summer oftentimes transfigures the world as well as the face of the setting sun.

I doubt if any other natural object has a color precisely like these slime molds. It is a red that is almost purple, yet not purple; it is a nuance of red, intriguing, ineffable, that leaves one guessing whether he sees a vibration of color or is receiving only a hazy, illusive impression.

### SLIME TRANSFORMS INTO SPORE-CASES

At one edge of the colony the slime molds were less crowded and, it seemed, less mature. In this place was visible a thin patch of glair, about the size of the palm of my hand, which glistened in the shadowy retreat like a filmy layer of silver-leaf (see page 443).

This patch of slime was significant. It was the last trace of a much larger portion that I had been watching for several days. Even had its nature been unknown to me, I should readily have divined the reason for the diminution of its size because of an event that was now taking place before my eyes — the long-anticipated transformation of the slime into the colorful colony of pretty sporangia just described.

When, a few days earlier, I had been prowling through the swamp, chance brought me upon the log. At that time it was mostly bare over the area now occupied by the slime molds, except for an exceedingly delicate and almost invisible pellicle of a creamy texture which caught my eye.

### THE MASS WAS MOVING

After studying the filmy mass I had become aware that it was moving. Spreading out fan-shaped, it advanced its borders almost as slowly as does the hour-hand of a clock. The rest remained stationary and was connected by a cordlike vein that led into a minute crack in the log.

As the advancing edge seemed to be the only part in motion and the area of the mass meanwhile was increasing, it was evident that the materials for this augmentation were coming from within the log by flowing through the vein.

I realized that a migration was taking place—that this curious mass of glair, which normally lives and grows in darkness in moisture-laden tissues of decaying wood, had arrived at the period of its existence when it must reach the outer air and light to reproduce and to enhance the favorable distribution of its spores.

During my visits on succeeding days, the only observable changes had been in the increasing area of the slime and in the shifting of its location. It had wandered, crossed and recrossed its path on the tree trunk, leaving a well-defined trail of organic refuse over its course. Yet slowly and continuously it had kept on the move, like some lost creature uncertain of its way, groping aimlessly about, apparently without other purpose than to follow the most fortuitous route. But in none of its excursions did it travel more than a yard along the length of the log.

Finally its traveling ceased and it began to separate into pellucid particles somewhat smaller than rice grains.

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A SPECIES OF SLIME MOLD FOUND THROUGHOUT THE WORLD

The delicate, funguslike organisms known as myxomycetes or mycetozoa are common in all the moist, wooded regions of the earth. Whether they are to be classed as plants or animals is a question upon which scientists are not yet agreed, although the organisms have been the objects of study for nearly 200 years. The above species is the Leocarpus fragilis, magnified 30 diameters.

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Painting from life by William Crowder

THERE ARE MORE THAN 500 SPECIES OF SLIME MOLDS

With few exceptions, the sporangia (spore cases) of slime molds are seldom more than a quarter of an inch in height, but while their minuteness renders the individuals inconspicuous, the habit of grouping into colonies oftentimes makes them an imposing spectacle. This species, Fuligo septica, enlarged 1½ diameters, is world-wide in distribution.

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Painting from life by William Crowder

SPORE CASES OF BADHAMIA PAPAVERACEA, ENLARGED 40 DIAMETERS

The spore is to the slime mold what the seed is to the higher or flowering plants and the egg to the higher animals. Like the spores of mushrooms (see the National Geographic Magazine for May, 1920) and of ferns (see the National Geographic Magazine for May, 1925), the spores of slime molds are microscopic bodies which germinate after coming into contact with water. But unlike the spores of true plants, which develop directly into other plants, the spores of the slime molds produce first an organism, a small colorless speck of protoplasm, which in a short time assumes an elongated pearlike form, carrying at its smaller end a thread or lash, which it whips around in the water somewhat in the manner of a traction propeller, thus carrying the microscopic organism into moisture-laden food precincts.

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Painting from life by William Crowder

A MEMBER OF THE PHYSARUM FAMILY

Individuals of this species (globuliferum) resemble tiny beads of porcelain or pearls strewn over dead leaves or wood. Enlarged 40 diameters. The sporangia of certain others of the same family are an intense black and nod at the end of hairlike stalks, reflecting from their glossy surface the blue of the sky; still others collect in groups and strike the eye with a startling shade of scarlet, staining the bark on which they appear like a splash of blood.

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TRICHIA PERSIMILIS IS FOUND THROUGHOUT THE NORTHERN WORLD

There are two distinct phases in the life history of slime molds—the vegetative and the reproductive. The vegetative phase is known as the plasmodium of the species. The substance of the plasmodium resembles the white of an egg in consistency, is slippery to the touch, tasteless and odorless. This specimen is enlarged 40 diameters.

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Painting from life by William Crowder

LAMPRODERMA ARCYRIONEMA OCCURS IN LARGE COLONIES ON BARKLESS, DECAYING LOGS. ENLARGED 40 DIAMETERS

In their plasmodial state (see under Color Plate V) slime molds are found in damp situations, and in warm weather they spread over moist surfaces and creep through cracks and rotting bark.

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Painting from life by William Crowder

THE CHASTE ELEGANCE OF THIS SLIME MOLD'S PROPORTIONS COMMANDS ADMIRATION

Stemonitis splendens is one of the commonest of the mycetozoa. Its slender, dusky sporangia sometimes reach a height of an inch or more, and resemble miniature attenuated spikes of the reeds known as "cat-tails." A good magnifying glass is needed to resolve the finer details of the intricate network of Stemonitis. Its loose and gauzy labyrinth of plasmodium (see under Color Plate V) has a weird charm and unearthly beauty all its own. Enlarged 10 diameters.

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PHYSARUM LATERITIUM RESEMBLES CLOSELY THE FAMILIAR "PUFFBALL"

The plasmodium of slime molds (see under Color Plate V) shows marked "irritability," avoiding strong light and seeking moisture and food. It frequently surrounds soft organic substances and completely digests them. Physarum lateritium is a cosmopolitan species, being equally at home in New York, Pennsylvania, Colorado, Ceylon, Java and Brazil. The species is magnified 50 diameters in this painting.

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THE IRIDESCENT HUES OF DIACHEA LEUCOPODA RIVAL THE TINTS OF A PEACOCK'S FEATHERS

This lovely species of mycetozoa is not uncommon in the Eastern States, but is rare west of the Mississippi. It is easily identified by its white stem. Enlarged 75 diameters.

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A GLITTERING SKIN IDENTIFIES LAMPRODERMA VIOLACEUM

This species sparkles in the breeze like the waters of an agitated pool in strong sunlight. It is our commonest slime mold, and is to be found late in the fall on decaying sticks and logs far and wide. Enlarged 40 diameters.

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COMATRICHA PULCHELLA IS PROBABLY WIDELY DISTRIBUTED BUT IT IS RARELY COLLECTED

The sporangia of this species are very minute, being less than one-twentieth of an inch high. Magnified 30 diameters.

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BEAUTIFUL DIDERMA TESTACEUM IS FOUND THROUGHOUT THE UNITED STATES

Most of the specimens of this slime mold in our Western States are found on dead oak leaves; in the East, they not infrequently gather on moss. When fresh this Diderma is easily recognized by its delicate pink color. Older specimens become white. Enlarged 40 diameters.

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Painting from life by William Crowder

WONDROUSLY WROUGHT DETAILS DISTINGUISH THESE ORNATE STRUCTURES

The spherical sporangia on slender stalks are like tiny baskets, the ribs and stays of which are represented by a latticelike wall of strange diametric design. The spores, a rich cinnamon brown oftentimes reddish in color, at first fill the little baskets to capacity, but eventually they make their escape through openings in the wall. At every slightest breath of air the baskets sway and jostle, strewing their burdens, pepper-box fashion, in all directions. This is Dictydium cancellatum, magnified 40 diameters.

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Painting from life by William Crowder

ARCYRIA FERRUGINEA, ENLARGED 18 DIAMETERS

Groping, streaming, pulsating, the silvery protoplasm of the Arcyria family of slime molds shoots its ghostly threads from moisture-laden logs and wanders over the bark to its place of development into one of the loveliest of natural wonders in miniature.

© National Geographic Society

Painting from life by William Crowder

ARCYRIA DENUDATA IS THE COMMONEST SPECIES OF ITS GENUS (SEE ALSO COLOR PLATE XIV)

This slime mold is equally at home as far north as Alaska and as far south as Nicaragua. Enlarged 18 diameters.

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Painting from life by William Crowder

SPECIMENS OF PHYSARUM VIRIDE MAGNIFIED 50 DIAMETERS, SUGGEST EGGS AND GOLF BALLS ABOUT TO PEEL

In the case of many of the slime molds the life history of the particular species has not been completely traced. They provide a subject which invites the attention of the student of zoölogy no less than that of the inquiring botanist.

This change came at dusk on the day preceding the dawn of our present inspection, and it came at an unseasonable hour, when I was not equipped with a light and when the fast-approaching night began to cloak in darkness the most interesting activities of this curious organism.

### THE SILVERY LIQUID BREAKS UP INTO MINUTE PEARLS

My early return to the locality was not without its compensation, for an entire colony of sporangia had sprung up over night. But I arrived almost too late to witness the manner of the transformation; for, even as I looked, the silvery splash of liquid light that still remained on the log began to break up into a compressed group of minute pearls. The globules at first were creamy white, but gradually they assumed a cast of delicate pink, and with the change in hue came a slow, though definite, alteration in the form and size of each unit.

The tiny gems were strewn in shapeless clusters of a single layer, as if the contents of some fairy treasure casket had been spilled upon the bark. In several instances they were so closely crowded that the soft, yielding bodies arranged themselves in geometrical order, like the hexagonal cells of a honeycomb or the facet eyes of giant dragon flies.

Eventually a more fundamental change occurred. By degrees the developing sporangia increased in dimension along their vertical axes and began to resemble short cylinders standing on end, the topmost part of each being slightly enlarged.

As the columns rose, gathering their substance from the surrounding slime, the globules topping them became less marked, until they completely disappeared when each little sporangium had reached a height equal to three times its diameter.

### THE INSECT WORLD GOES INTO ACTION AGAINST THE OBSERVER

Before this stage was reached, however, the sun was more than four hours old and the oppressive atmosphere of the swamp began to assert itself.

The rising temperature set the insect world in motion. Wasps and bees hovered uncomfortably close, respecting my person only while I was puffing vigorously at my pipe. Occasionally the sting-bearers would crawl over my face and hands, and although they made no attempt to attack, their presence was distracting, lest I should forget and make an incautious movement.

The mosquitoes, the gnats and buzzing flies, on the contrary, considered my welfare not at all; whole tribes took telling toll of my lifeblood.

Round about, a more attractive crowd appeared. Gaudy butterflies settled lazily upon brilliant blossoms, uncoiled their siphons and thrust them deep into the hearts of flowers. A great moth, startled from its hiding place, flick-flacked its way here and there excitedly, the metallic blue of its wings flashing in the shade like a fragment of the sky.

Grazing the ground in its characteristic low flight, a somber ichneumon fly went hesitatingly by on powerful bronze-black wings, halting to explore some bit of ground or likely plant, in its search for prey.

Now my nostrils were assailed by the heavy odor of a near-by stinkhorn toadstool, which loosed its strangling stench on the humid air.

### THE CLIMAX OF THE TRANSFORMATION SPECTACLE

Despite these distracting factors, I continued to watch the growing columns of the slime molds. The nascent sporangia were now becoming diffused with a deeper tone of pink, particularly at their bases. For the first time, I noticed that the cylinders were no longer in actual contact with the wood; a hairbreadth space had intervened, and they were slowly being elevated into the air, as the stalks began to form.

These threadlike stalks, which were of a deep tone of garnet red, gradually reached a length of one-half the entire organism and expanded like cups at the top.

The flaccid group had by now lost its compressed, or honeycomb, appearance; each individual unit stood staunchly upright, independent, seemingly apart from its neighbors, yet in crowded contact with them. The surface now began to dry, and

TRICHIA DECIPIENS (ACTUAL SIZE) IS AN INHABITANT OF WET LOGS
Colonies of this species of slime mold often cover areas of a square yard or more.

Photographs by William Crowder

DIDERMA TESTACEUM, SLIGHTLY ENLARGED
Compare with Color Plate XII of the same species.

Photograph by William Crowder

A SLIME MOLD TRAVELING

In this stage the plasmodium moves slowly about in search of food and moisture. Later it will develop into a beautiful object, similar to one of those shown in the Color Plates.

simultaneously the iridescent covering of filmy skin began to peel into shreds and tatters.

On the wings of the imperceptible movement of heavy swamp atmosphere, these fragments vanished, and—presto! there was revealed that wonder of wonders, a gauzy tangle of spore-laden threads called the capillitium.

The sporangia were now fully formed. There was no further increase in the length or breadth of any part. The plasmodial slime was completely exhausted. The microcosmic spectacle was at an end!

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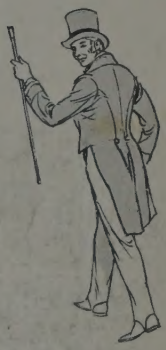
Photograph from Dr. W. L. Schurz

EGRET PLUMES IN THEIR PROPER PLACE: AMAZON VALLEY

The exquisite egret (the snowy, or little, heron) has suffered so much persecution at the hands of plume hunters that it has been appropriately called the bird of tragedy. In former years great flocks of these snowy creatures covered the banks of Amazonian lakes like a sheet of dazzling white. The plumes are most beautiful in July.

# *Something few people know!*



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